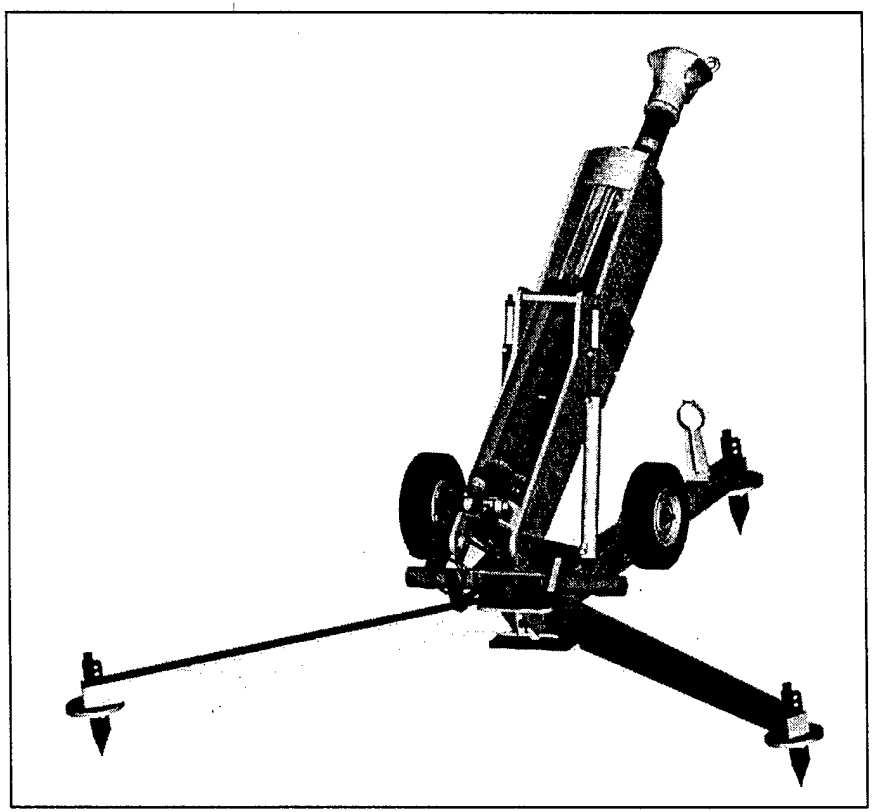
EMERGING TECHNOLOGIES FOR LIGHTWEIGHT ARTILLERY SYSTEMS



- Electro-rheological (ER) fluids to enhance recoil control
- Isogrid structures to reduce weight while maintaining strength
- Technologies can be applied to any artillery system

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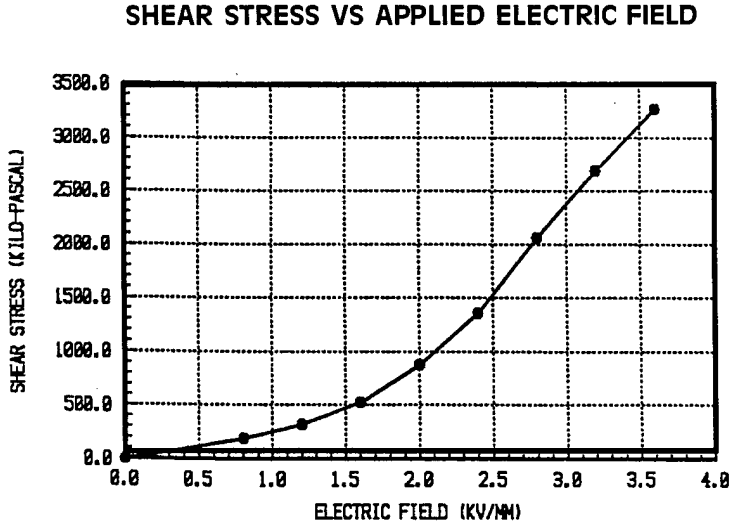
6-3-98

GENERAL ATOMICS

ER FLUID PROPERTIES

- ER fluids are dispersions of solid particulates in an insulating oil
- Fluid viscosity changes when electric field applied
- Functions as an electronic brake
- Controls motion and forces
- Fast response time (1 to 2 msec)
- Closed loop adaptive control
- Fully reversible



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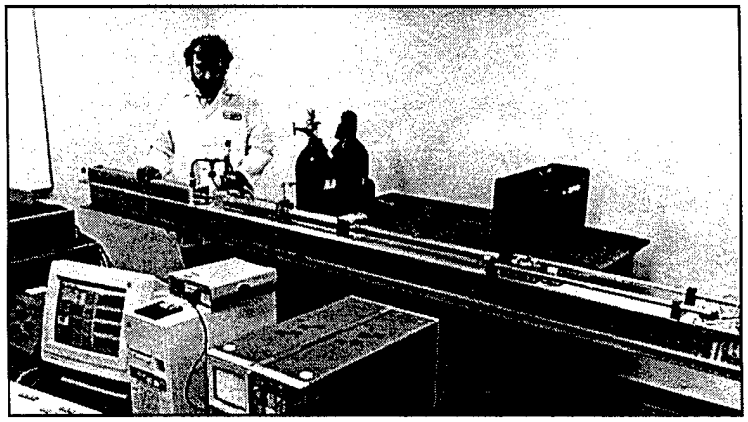
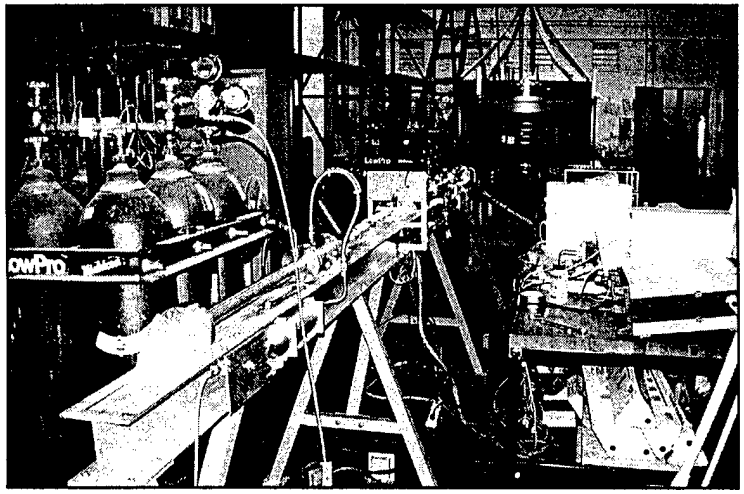
GENERAL ATOMICS

ER FLUID RECOIL CONTROL
SUBSCALE HARDWARE SYSTEMS

Conventional recoil test hardware

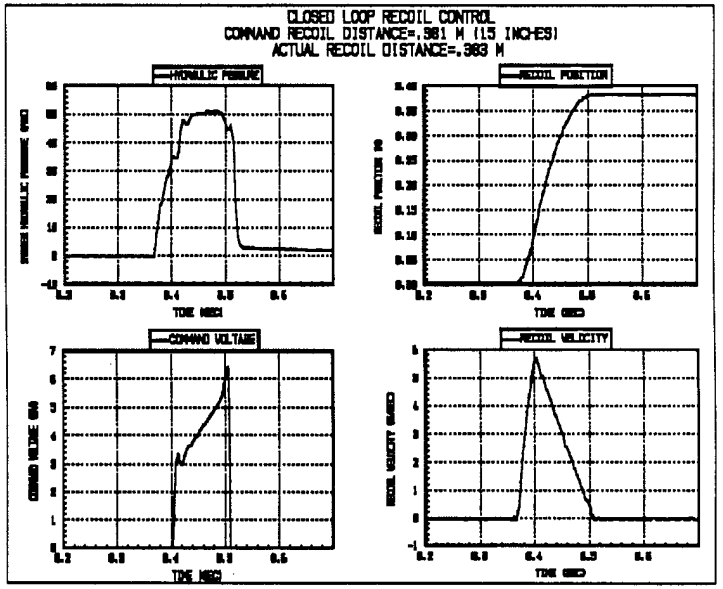


Soft recoil test hardware



Results

- ER Fluid control demonstrated (Full scale stroke, velocity and timing)
- Control instrumentation,data acquisition and software validated
- Established scale factors for full scale design and simulation



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GENERAL ATOMICS

ER FLUID TECHNOLOGY DEVELOPMENT AT GENERAL ATOMICS

Have applied ER fluid technology to practical applications since 1987

ER Device	Application	Agency
Recoil Arrestor	Artillery System	Armament Research Development And Engineering Center
Clutch	Underwater Vehicle Propulsion System	Naval Underwater Warfare Center
Suspension System	Magnetically Levitated Train	Federal Railroad Administration
Acoustic Damper	Underwater Vehicle Noise Suppression	Naval Surface Warfare Center
Elastomer Vibration Damper	Underwater Vehicle Rotating Machinery Mounts	Office of Naval Research

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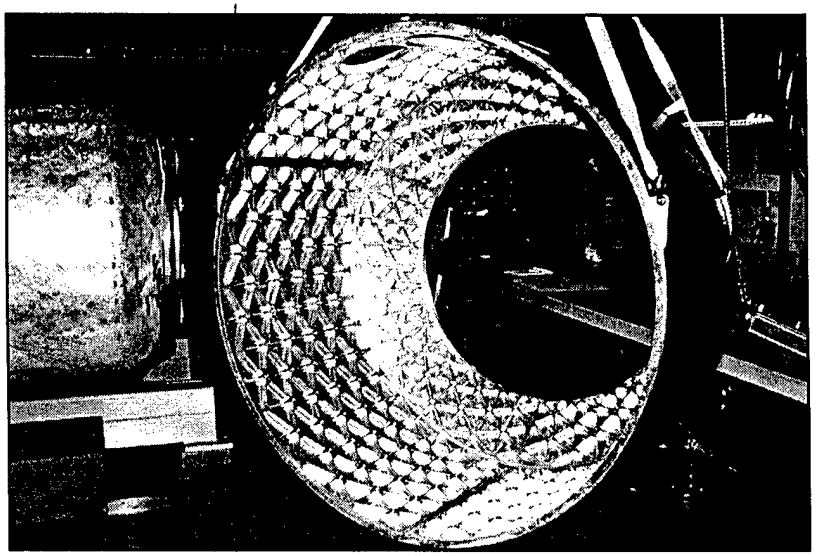
GENERAL ATOMICS

WHAT IS ISOGRID?



"iso" means Isoceles triangle!

Isogrid is:

- An all metal ultralightweight structural technology
- Stronger than equivalent high strength/low weight plate structures of the same weight
- Infinitely variable in local strength; strength always matched to loads
- Structures analyzed using codes inherited from long-term aerospace projects

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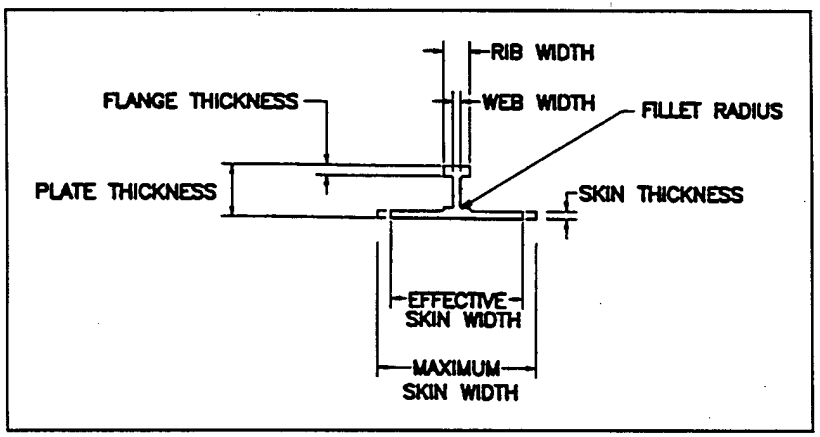
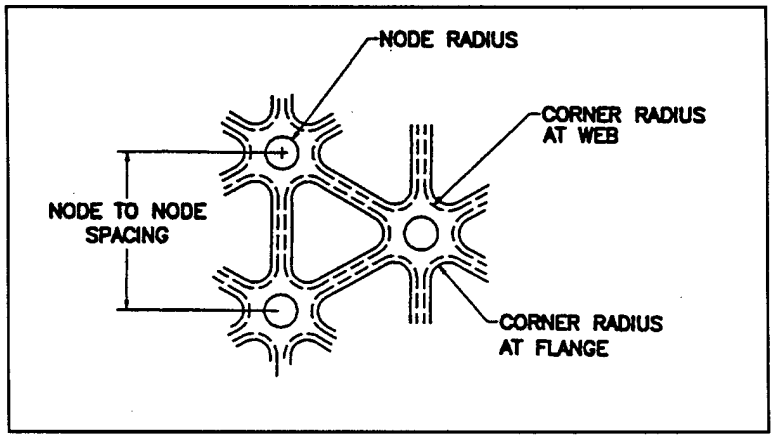
GENERAL ATOMICS

WHY IS ISOGRID TIMELY AND APPROPRIATE?

- 30 yrs aerospace experience/analysis for low cost
- Computer numerically controlled (CNC) machine tools are now almost universal
- All-metal construction beats honeycomb or composites for rugged Howitzer service
- Labor cost in production is minimized (less welding and machining of weldments)

WHY IS ISOGRID EFFICIENT?





"EFFICIENCY" MEANS HIGH PERFORMANCE WITH LOW WEIGHT

- Isogrid plates are thick but light
- Bending strength increases greatly with plate thickness
- The thin skin contributes because it doesn't buckle under loads - the ribs prevent skin buckling
- "SST" computer analysis allows every feature of the grid geometry to be optimized - no wasted metal